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ABSTRACT

The purpose of this research was to determine what effects, if any, widening or narrowing the response repertoire has on measures of IQ and problem solving of preschool children. It was predicted that response widening, or creative/divergent thinking, would have a positive effect on IQ and problem solving. Forty-one preschool children 3 to 6 years of age were divided into three matched groups. One group was exposed to response widening tasks, while a second group was exposed to response narrowing tasks. A third group served as control. Special training with response narrowing and response widening tasks was provided for a 3-hour period twice each week for 6 weeks. The Wechsler Preschool Primary Scale of Intelligence, the Torrance Thinking Creatively with Action and Movement, the convergent ad divergent subtests of the SOI Learning Abilities Test, and the Kaufman Assessment Battery for Children were administered during pre- and post-tests. Results indicated that response widening had a positive effect on IQ, with training being most effective for younger children with average IQ scores on the pre-test. Contrary to the hypothesis, problem solving increased for all groups. (Author/RH)

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THE EFFECT OF RESPONSE WIDENING AND RESPONSE NARROWING ON IQ AND PROBLEM SOLVING

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ABSTRACT

The purpose of this research was to determine what effects, if any, widening or narrowing the response repertoire has on measures of IQ and problem solving of preschool children. It was predicted that response widening, or creative/divergent thinking would have a positive effect on IQ and problem solving. To explore this hypothesis, 41 three to six year olds were divided into three matched groups. One group was exposed to response widening tasks, while a second group was exposed to response narrowing tasks. A third group served as control. Special training was provided for a three hour period twice each week for six weeks. The Wechsler Preschool Primary Scale of Intelligence and the Kaufman Assessment Battery for Children were administered individually during pre- and post-tests. The results indicated that response widening had a positive effect on IQ, with training being most effective for younger children with average IQ scores on the pre-test. Contrary to the hypothesis, problem solving increased for all groups.

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Young children who have special abilities need a program which challenges and reinforces those abilities. Amid cries of "elitism" and unnecessary social isolation of these special students, the fact remains that in order for this society to continue to grow technologically, scientifically and economically, the next decade will need "super-thinkers"--individuals who can process vast amounts of information quickly and accurately to produce effective solutions to problems.

Preschoolers are by nature problem solvers; their openness to ambiguities, their need for flexibility, their independence and curiosity makes them prime candidates for "super-thinking." Recognizing that many of the characteristics of preschool children are traits which will identify "gifted" or "talented" children in the primary grades, the Upper Quartile@ program has been developed with these characteristics of preschool and gifted children in mind: (1) rapidly developing language skills; (2) increased (sometimes labelled "hyper") activity level; (3) intense interest in unusual subject matter; (4) curiosity and attention to details; and (5) desire to structure one's own learning tasks.

However, there is some dispute whether super-thinking relies on convergent or divergent abilities. Divergent production emphasizes variety and quality of input, while convergent production emphasizes the generation of conventionally accepted best answers (Meeker, 1969). The preponderance of work done with young children has supported the viewpoint that advanced thinking can best be fostered through the use of convergent materials. A substantial body of research concludes that problem solving is primarily a convergent process which leans heavily on intellectual ability.

However, there is room for an expanded viewpoint. If intellectual ability is the "capacity to acquire new capacity" (Cattell, 1971, p.8) or "the ability to process information effectively as a means of solving unfamiliar problems" (Kaufman & Kaufman, 1983, p.2) then intelligence relies more on creative abilities. In a study of childhood patterns of genius, Nicholls (1972) identified four characteristics: (a) task commitment associated with convergent style, (b) intelligence, (c) ideational fluency or divergent thinking patterns, and (d) a preference for complexity and disorder associated with creative individuals. Further, divergent or creative thinking is the critical factor for behaviors such as social make-believe play (Johnson, 1976), brainstorming (Dirkes, 1978), evaluation and higher process thinking (Thomas & Holcombe, 1981). Indeed, individuals who are regarded as creative are

not only fluid producers of original and clever ideas, but their ideas have been judged as "good" according to certain quality procedures (Houtz, Montgomery, Kirkpatrick, and Feldhusen, 1979).

The primary purpose of this study was to demonstrate that preschool children use divergent or creative methods to solve problems. Further, it was intended to show that the ability to process information represented by a novel stimulus or to solve unfamiliar problems can be improved by training. A program which encourages divergent thinking would not only have a greater effect on problem solving than a program which encourages convergent thinking, but also would have a greater positive effect on IQ.

Method

The Upper Quartile Program offers a new model for structuring an environment that encourages children to think creatively and initiate their own activity. The purpose of the program is to develop problem solving skills in young children and to utilize two types of high level thinking. These are called response narrowing and response widening.

Response narrowing (RN) is the kind of problem solving that looks for right answers. The child is given bits and pieces of information, and partial solutions which he must unify to find a correct answer. Questions such as "How much is 2 + 4?," "Is 'car' or 'carry' a noun?," and "What is the 6th letter of the alphabet?," rely on narrowing thinking strategies, as do a majority of questions on standardized achievement and intelligence tests. (As a point of reference, by the time the child completes the 12th grade, it is estimated that as much as 80 percent of his school work will have relied on narrow thinking.) Response narrowing is illustrated in Figure 1.

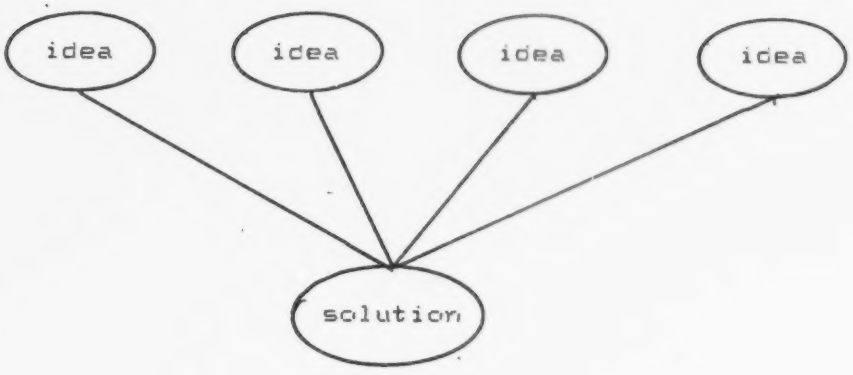

Fig. 1. RESPONSE NARROWING

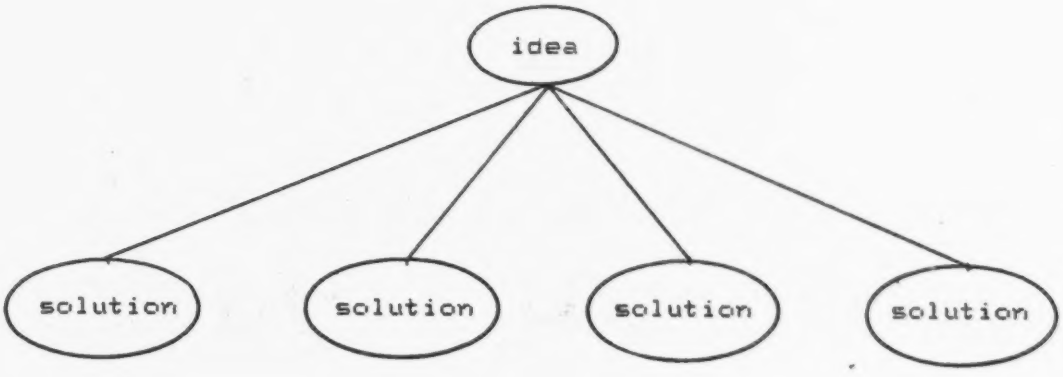

Fig. 2. RESPONSE WIDENING

Response widening (RW), shown in Figure 2, is the kind of problem solving that says all answers are acceptable, a good answer is not necessarily the best answer. The child is introduced to the problem and he generates his own solutions from there, analyzing data from many angles before suggesting possible solutions. Some examples: "What could you do if you were as big as your father?," "How could you make a house out of rubber?," "What would it be like to have a birthday every day?," or "What can be made out of wood?."

Initially, the Response Widening materials were selected from the Divergent Production Sourcebook (Meeker, 1969). Similarly, the Response Narrowing materials were selected from the Convergent Production Sourcebook (Meeker, 1975). Control group materials were traditional early childhood materials such as puzzles and other manipulatives, blocks, and dramatic play which developed memory, psychomotor, and language skills.

However, during the field test of the SOI materials using subjects who were not included in the final sample, many of the tasks were rejected for use with young children. In some, the pieces were too small. In others, the pictures were unattractive, or the children lost interest before a task was completed. More importantly, five tasks which were interesting to the children were rejected by the researcher as innappropriate for the project. Similar tasks were found in both sourcebooks. Tasks identified by SOI as convergent elicited responses more indicative of divergent thinking, and vice versa. Since the remaining materials were not sufficient to form a six week training program, the researcher designed supplementary tasks which met the criteria for RW and RN tasks (see Figure 3). Montessori materials and the readiness materials from pre-kindergarten workbooks were added to the RN program; imagination games, creative dramatics, and similar activities supplemented the RW tasks.

Forty-one (41) children between the ages of 4 and 6 (mean age 54.6 months) were recruited from a day care center at a junior college and a parochial mother's day out program. Using stratified random sampling, the children were assigned to three training groups: a response widening (RW) group; a response narrowing (RN) group; and a control group. The groups were matched by age, sex, and degree of previous exposure to early childhood materials. Since it was believed that IQ would not be a confounding variable, the groups were not matched on IQ prior to training.

Figure 3

Criteria for Response Widening and Response Narrowing Tasks

RESPONSE NARROWING

1. Is there a pattern to follow or a correct way to perform a task?

2. Do the details within the task lead the child to one solution? (Raindrops on the window, umbrella and raincoat by the door would indicate that someone has just come in from the rain.)

3. Must the steps involved in completing the task be done in a particular order?

4. Does the child understand that he is looking for a single best right answer?

5. Does the child match, define, sequence, select from a list the most appropriate answer, copy or complete a pattern?

RESPONSE WIDENING

1. Is the child allowed to experiment freely with the materials?

2. Do the details within the task allow the child to come up with more than one solution that is acceptable?

3. Can the steps involved in completing the tasks be done in any order?

4. Are open ended questions used? Does the child understand that many answers are acceptable?

5. Is the child asked to describe how he knows an answer? Does the child describe, classify, create, invent, imagine, develop possibilities for, or hypothesize?

Prior to training, all children were evaluated using a battery of four standardized measures. The Wechsler Preschool Primary Scale of Intelligence (WPPSI) was used to measure IQ. The Torrance Thinking Creatively with Action and Movement (TCAM) was used to measure creativity. The Kaufman Assessment Battery for Children (KABC) was used to measure problem solving ability. The convergent and divergent subtests of the SOI Learning Abilities Test (SOI-LA) were used to assess the content validity of RW and RN materials with divergent and convergent materials. The same examiner administered all the tests to each child in an individual setting. At the end of the six weeks of training, the children were retested using the four instruments of the pre-test. The same examiner administered the tests.

The children received six hours of specialized training per week for six weeks. There were two three-hour sessions each week. One teacher supervised the training sessions for the RN and RW groups, while a second teacher supervised the sessions for the control group. Using the criteria for RN and RW tasks, the lesson plans for all three programs were checked for exclusivity and appropriateness by an outside supervisor.

Since the subjects were not matched on IQ, the pre-test IQ scores among the groups were compared using a one-factor ANOVA. Further, each group mean was tested against the population mean using a t-test. Analysis of the pre- and post-test IQ scores was conducted using a two-factor ANOVA (group, test administration) with repeated measures on one factor (test administration). A similar two-factor ANOVA was used to analyze the pre- and post-test scores of the K-ABC. Multiple comparison tests were planned in the event that significant results were obtained on any factor involving three or more levels.

Results

Statistical analysis of the data collected from the subjects in pre- and post-tests revealed a complex relation between the type of training and the changes in IQ and K-ABC scores. As will be reported below, the RN group had the greatest gain in the K-ABC score, but the lowest gain in IQ. The control group had the median gain in both. The RW group had the lowest K-ABC gain and the highest IQ gain. However, the pre-test mean for IQ was lower for the RW group than for the other two groups. While an ANOVA performed on the pre-test IQ scores did not achieve significance, a strong trend was indicated ($p=.0902$, $F=2.54$, $df=2,38$).

Examination of the group means clearly shows that the strong trend indicated by the ANOVA resulted from the differences between the RW pre-test IQ score and those of the other two groups.

Given the indication that the changes focused on the elevation of the lower IQ scores, a test of this phenomenon was deemed appropriate. A one-factor analysis of covariance (ANCOVA) was accomplished in which the factor was four levels of pre-test IQ scores (80-99, 100-109, 110-119, 120 and up). The post-test IQ scores were analyzed for these four groups using pre-test IQ scores as covariates. A significant difference among the groups was indicated ($p=.030$, $F=3.37$, $df=3,37$). A post hoc Scheffe test found that only one difference was significant. The group with the lowest pre-test IQ scores showed a significantly greater gain than the group with the highest pre-test IQ.

It was hypothesized that specialized training of either type would increase WPPSI IQ scores from pre- to post-test, however the increases for the RW group would be greater than the RN group. A two-factor ANOVA with repeated measures on one factor was used to evaluate the hypothesis. As stated, the hypothesis was not supported. No significant differences among the three groups across test administration was found. A significant increase in IQ scores between test administrations across groups was achieved ($p<.025$, $F=5.98$, $df=2,38$). A strong trend was indicated in the interaction of the two factors, time and training ($p<.1$, $F=2.93$, $df=2,38$).

Since it had been assumed that problem solving was a creative activity, it was also hypothesized that response widening would have the greatest effect on the Kaufman Mental Processing Composite. A two part ANOVA with repeated measures showed only a significant change from pre- to post-test for all groups ($p<.001$, $F=29.96$, $df=1,38$). Non-significant results were indicated among groups across trials, and in the interaction between groups and trials.

Separate t-tests for related samples showed that the means for all three groups increased signicantly from pre- to post-test. The combination of the results from the ANOVA and t-tests would indicate that any changes in problem solving ability were due to maturation and not training.

The degree of relationship between the K-ABC Mental Processing Composite and the WPPSI Full Scale IQ was determined by computing a Pearson correlation coefficient for all pairs of scores for both test administrations. The resulting correlation, $r = .578$, was found to be significant

($p<.0001$, $t=5.17$, $df=60$). However, this level of correlation is equivalent to a shared variance of only 33.4 percent between the two tests.

Discussion

Even though there were no significant differences among the IQ gains made by each of the training groups, the implication is that a curriculum model based on widening and narrowing of the response repertoire is quite viable. Although it had been previously assumed that high level tasks would be out of the developmental range of preschoolers or young children with average IQs, this did not hold true. Many of the strategies used with the RN and RW groups had been designed to be used with gifted children. It could be inferred that a high IQ should have been necessary to accomplish these tasks. However the group with the lowest mean pre-test IQ made the most progress through training. If it could be demonstrated that training of this type affected the performance of children of average intelligence, it would be inappropriate to reserve higher level strategies for children with IQs greater than 120. A one-factor ANCOVA and a subsequent Scheffe showed that the lower IQ group (IQ=80-99) had gains significantly different than the high IQ group (IQ=120+). In effect, the materials were the most effective for the younger child with an average IQ.

To assess the affects of the RW/RN curriculum on problem solving, several steps will be taken in future studies. First, a more appropriate test of problem solving must be found (or developed). The Kaufman test is described as one of problem solving but appears to have a theoretical foundation that supports the concept of problem solving as an inherent capability within the child rather than being teachable. The high correlation between the Kaufman and IQ scores also raises some questions about the true nature of what the K-ABC scores measure. Next, the control group program will be limited to day care. This will limit the research to examining the effects of a program versus no program on teaching problem solving. Once it can be shown that preschool children can be taught this skill, then the RW/RN methods can be evaluated against others. Finally, groups will be matched on IQ and previous exposure to early childhood materials. While it would be ideal to have subjects who had not been exposed to any prior preschool program, this is impractical given the pervasiveness of early childhood programs. Matching subjects on experience is the best alternative to minimize the effect of experience on the research design.

The results of the last field test in the summer of 1984 were so encouraging that the developers of the Upper Quartile program believe that the program is a viable model for young children, particularly for those children who have found other models too restrictive or not challenging enough. Both RN and RW materials increased problem solving abilities and scores on standardized IQ tests more than traditional nursery school materials. RW materials increased the level of creative thinking as well.

As a final point, it can be demonstrated how powerful the Upper Quartile paradigm is by combining RN and RW strategies. This is illustrated in Figure 4. Suppose the child learns to approach problems using both RW and RN strategies simultaneously. Each idea suggests many solutions; a pattern within the anticipated solutions suggests an answer more profound than could even be found without the intermediate step. An example: one of the Upper Quartile's first activities gives each child a plastic tub to fill with anything they could play with, like sand in a sandbox. Children fill boxes with styrofoam pieces, cornmeal, sugar, pea gravel, dirt and sawdust. The first time the wind blows, the children who suggested styrofoam and sawdust opt for marbles and plastic pellets. The first time it rains, sugar and dirt are traded for kitty litter and egg shells. Ants are attracted to cornmeal so that child trades for soap crystals which are found to be scratchy. Pea gravel won't sift or hold a shape from a mold so that child tries rice and/or Cheerios. The children discover that just finding something fun to play with is not all there is to the problem. They must find a substance that won't blow away, won't melt, won't attract animals, will return to a natural state after a rain, can be sifted, molded, poured, is not too heavy nor too expensive.

Young children need programs which not only tolerate, but encourage, their curiosity and desire to reach out to the environment. Any child who enjoys a challenge is a prime candidate for "super thinking" -- the kind of expanded response repertoire fostered by Upper Quartile tasks. And the world will need "super thinkers" to accommodate the challenges of the future.

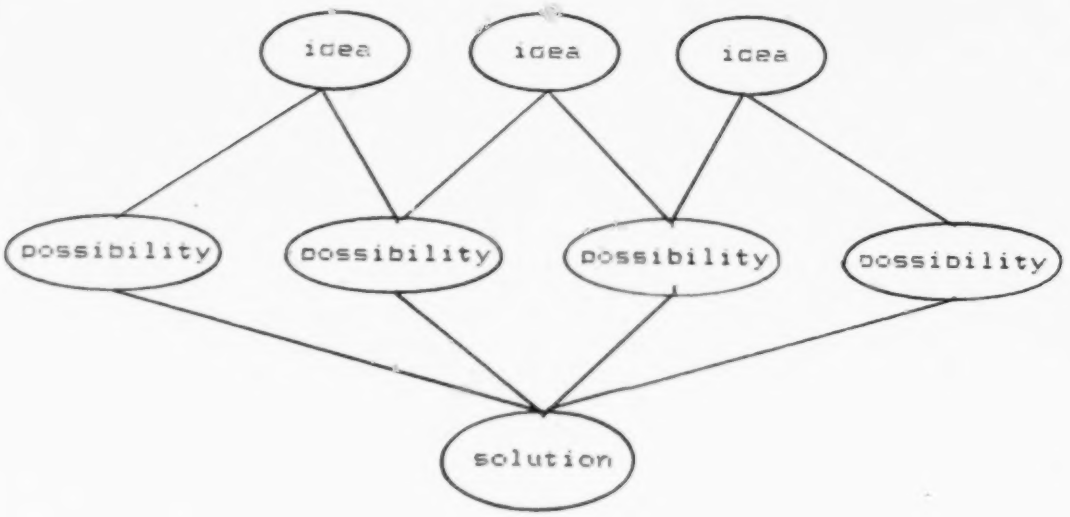

Fig. 4. UPPER QUARTILE THINKING MODEL

Upper Quartile materials are being further refined and validated at the Clear Creek Children's Institute in Houston, Texas. Questions and comments concerning the Upper Quartile Program are encouraged and should be directed to:

Dr. Diane Kane, Executive Director
The Clear Creek Children's Institute
16811 El Camino Real, Suite 113
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